Measuring Sustainable Development: Energy Production and Use in Canada

National Round Table on the Environment and the Economy (NRT)

MEASURING SUSTAINABLE DEVELOPMENT: ENERGY PRODUCTION AND USE IN CANADA

Montreal, Quebec

92-06635/

PREFACE

A primary goal of the National Round Table on the Environment and the Economy (NRT) is to better integrate economic activity with the environment. The mandate of the NRT is to identify, explain and promote the concept of sustainable development for all sectors and regions of the nation. An independent body, the NRT provides advice to the Prime Minister on sustainable development, and acts as a catalyst for change. This report flows from the catalytic role provided in the mandate.

Context

Indicators to operationalize and measure progress toward sustainable development is one area of activity categorized as "tools for sustainability." Other such tools include economic policy instruments to complement and enhance regulation, applying the principles of consensus decision making to issues linking the environment and economy, improving management skills for sustainable development, and ensuring that lines of accountability for decisions are clearly established.

Dozens of quantitative economic indicators are compiled and used each day to guide decisions relating to the economy. Many people believe that similar indicators are necessary to guide decisions that may have an effect on the environment. Sustainable development indicators are intended to connect these two types of measures either in the form of single ratios, or combinations of indicators to be used concurrently.

Performance indicators are needed to assess progress toward or away from sustainable development in Canada. More specific indicators can be used to measure progress toward established Canadian goals and targets for sustainable development, such as those set for some air emissions. Indicators can also help to evaluate the effects of policy instruments applied to specific environment-economy problems and thereby improve accountability.

Energy Indicators

The NRT selected the topic of the sustainable production and use of energy as its first area of activity on indicators. This topic was chosen because energy cuts across many issue-areas related to sustainable development. Energy also has a relatively well-documented data base to support indicator development, and is sufficiently controversial that it might provide a tough "test case" for developing indicators on other topics.

If this process worked well for energy (arguably the most difficult sector), then indicators for several other sectors could be similarly handled. Ultimately, a list of key indicators for enough sectors would provide an overall measure of progress toward sustainable development in Canada. As part of the catalytic role of the NRT, it was expected that a successful initiative would lead other groups to take the lead on developing indicators for sectors relevant to them.

The Future of Indicators

Since this workshop was held, indicators have increased in importance and profile. Dozens of organizations, both nationally and internationally, are engaged in indicator development.

Indicators are of increasing importance to international negotiators working to develop agreements on various issues that require a cooperative, transnational or global approach. The indicators selected to measure compliance with various international agreements can have significant implications for different nations. Each of the suggestions and recommendations found in bold printing in the last chapter are being followed-up by the National Round Table. Recognizing the growing interest in indicators and the increasing importance placed on their selection, the National Round Table on the Environment and the Economy is working to ensure that indicators are selected through a broadly-based, multistakeholder process.

ACKNOWLEDGEMENTS

Preparation of the background reports, peer reviews, workshop preparations and execution, and follow-up could not have been achieved without the support of many individuals and organizations. First among equals were the support team provided to the National Round Table by the firm of Ernst and Young: Fraser Wilson and Jane Hawkrigg. Their unstinting effort on behalf of the former Socio-Economic Committee of the National Round Table was decisive in making the initiative a success. Their *pro bono* work for the NRT has demonstrated a commitment to sustainable development in Canada that can serve as a model for all. Staff from Energy, Mines and Resources Canada gave unsparingly of their time. Donald Wilson can be credited with ensuring that the conference was a logistical success. The cooperation of Environment Canada and the Canadian Environmental Advisory Council was essential in preventing duplication of effort. Volunteers from many organizations assisted in reporting from the many concurrent workshops during the two-day event. The firm of W.E.S.T. provided facilitation support and prepared the initial draft of the final report.

Presentations to the workshop by Hans Rode from Sweden and Cynthia Praul Wright from the United States described similar efforts in their nations. A cooperative tone of finding and acting on common interests was set by the distinguished panel: Tony Reinsch from the Canadian Energy Research Institute (CERI), Michael Robertson from PetroCanada, Charlie Ferguson of INCO, David Runnalls of the Institute for Research on Public Policy (IRPP), and George Matheson, the author of the discussion paper for the NRT. A list of participants is included in Appendix 1 of this report.

Chairing of the various sessions was shared by two members of the National Round Table: Pierre Marc Johnson and Jim MacNeill.

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EXECUTIVE SUMMARY

Forty-eight representatives from industry, government (municipal, provincial and federal) and the academic and consulting communities met in Montreal on February 28, 1991 and March 1, 1991 to discuss indicators of sustainable development for energy production and use in Canada. The workshop was sponsored by the former Socio-Economic Impacts Committee of the National Round Table on the Environment and the Economy (NRT).

Workshop participants generally agreed that a family of indicators at the national level (macro indicators) would be useful in charting and assisting Canada's course towards sustainable development. Furthermore, it was thought that a set of credible measures, ones which are meaningful to both decision makers and the general public, could help to promote consistency and fairness in policy initiatives within Canada and internationally.

Participants considered a preliminary set of 15 indicators related to energy production and use proposed in a discussion paper commissioned by NRT. There was a high level of support for indicators of sectoral energy efficiency (energy used per unit of product or service provided within a particular sector) and impacts on environment (air and water emissions and waste). Many participants also stated that measuring the diversity of the national energy mix would be useful.

On the other hand, there was mixed support for proposed national indicators of energy intensity (energy use per capita) and aggregate energy productivity (GDP per unit of energy used). Some participants thought these indicators could be useful within Canada to track trends in economic reliance on energy. However, most participants agreed these two indicators were less useful for international comparisons because they inaccurately portray Canada's performance regarding energy use and efficiency.

Canada's relatively small population combined with an economy based on primary production and export creates high energy use per capita. It was also suggested that these indicators fail to take into account the energy-intensive nature of Canada's export trade. Many of Canada's products destined for export require energy-intensive development of natural resources. It is possible, for example, for each sector of the Canadian economy to be highly energy efficient, yet overall Canadian performance as measured by GDP per unit of energy to appear quite bad relative to other nations with quite different economic structures.

The appearance of poor performance may be caused by the underlying structure of Canada's economy relative to other developed nations, based as it is on primary production and export of such goods as minerals, forest products, petroleum and chemicals, and agriculture. Some participants cautioned that Canadian industries would be disadvantaged if international agreements or domestic policies were developed based on these indicators as measures of sustainable development.

Recognizing that the preliminary set of national indicators discussed at the workshop focused on environmental sustainability, participants proposed expanding indicators to include socio-economic considerations which also are a vital part of sustainable development.

Participants generally agreed that development and use of micro indicators at the corporate and organizational level should be encouraged. Micro indicators could measure outcomes such as emissions or energy efficiency, as well as contributing factors such as dollars spent on pollution control and environmental training of staff. It was suggested these corporate and organizational level indicators are more likely to motivate changes in behaviour than are macro indicators at the national level. Provincial and territorial round tables, industry associations, municipalities and non-government organizations, such as environmental groups, were seen as parties who would be interested in developing and promoting the use of micro indicators.

There was no clear direction from the workshop about who should take primary responsibility for the development of sustainable development indicators of energy production and use. At the national level, previous work on indicators by Environment Canada (State of the Environment Reporting), the Canadian Environmental Advisory Council, and Energy, Mines and Resources was recognized as significant. At the corporate and organizational level, professional associations were identified as key players in developing micro indicators. It was suggested that NRT should provide criteria and guidelines for developing indicators, promote the development and use of indicators at the macro and micro levels, and collaborate with other groups better suited to do the technical work.

Given all the work currently being done on indicators, the need for a national framework to help determine the essential indicators of sustainable development was recognized as fundamental. This framework would include sustainability criteria which could build upon the preliminary set of criteria developed by the policy group at the workshop. As well, a need to set clearly defined goals and targets for sustainable development was identified. Indicators could be used to measure

progress towards these goals. It is noteworthy that participants stressed the need for a policy framework to be developed through a consensus building process involving all affected sectors.

1.0 INTRODUCTION

A workshop — "*Measuring Sustainable Development: Energy Production and Use in Canada*" — was sponsored by the National Round Table on the Environment and the Economy (NRT) in Montreal on February 28, 1991 and March 1, 1991. The workshop was designed to discuss indicators of sustainable development related to energy production and use. Indicators provide data that help to monitor and assess a current state or situation and to detect changing conditions and trends. These practical measurement instruments are increasingly seen as important management tools which can be used to chart and track the course towards a sustainable future. The energy sector was chosen as the focus of this first workshop on sustainable development indicators because this sector is fundamental to the Canadian economy and because major global issues such as third world development, global warming and acid deposition are directly linked to energy production and use.

The National Round Table on the Environment and the Economy (NRT)

The National Round Table, formed in 1989, was established to identify, explain, and stimulate the acceptance and implementation of sustainable development by all Canadians. Acting as a catalyst for change and for the development of consensus; the NRT seeks to achieve its goals by developing new ideas that illuminate the important link between the environment and the economy. With multistakeholder membership, the NRT explores a range of issues from waste management, education, decision-making, prosperity and competitiveness to the socio-economic impacts of sustainable development. It is in this latter context that this workshop was held. An independent body, the NRT advises and reports directly to the Prime Minister. Prior to providing advice, the NRT seeks a broad-based consideration of issues by stakeholders.

Goals of the workshop were:

- to provide advice on a draft series of indicators for sustainable development in energy production and use at the national level (macro indicators);
- to identify practical links between macro (national and international level) and micro (individual or corporate level) indicators;
- to share information and experiences of participants;
- to test the effectiveness of this process in developing acceptable indicators for other topics;
- to encourage other groups to take the lead in developing indicators relevant to them and;
- to identify next steps for progress.

Forty-eight individuals representing energy suppliers, energy users and energy policy makers in government and academia participated in the two-day workshop. A list of participants is provided in Appendix 1.

The workshop programme is contained in Appendix 2 and the full discussion document that formed the basis for the workshop is found in Appendix 3. The workshop began with a panel discussion on a proposed set of national indicators. This was followed by small group discussions (seven small groups in total) on the need for a national set of indicators and the appropriateness of those proposed. Areas of agreement and disagreement were highlighted in plenary. Participants then divided into four groups — two of energy suppliers, one of energy users and one of policy makers. The energy suppliers and users groups developed lists of indicators which are or can be used at the corporate or organization level and examined their links with the proposed set of macro indicators. The feasibility of aggregating micro indicators into macro indicators was discussed as were gaps in the proposed indicators. The policy group, on the other hand, took a different focus. This group discussed the role of indicators and developed a list of sustainability criteria which would help determine what indicators of sustainable development should measure. Findings of all groups were reported in plenary. On the final day of the workshop, energy suppliers, users and policy-makers groups all discussed next steps or recommended actions to achieve progress in the development and use of indicators.

2.0 ARE NATIONAL INDICATORS USEFUL?

Workshop participants generally agreed that a set of national (macro) indicators is a useful management tool to:

- measure current conditions and trends;
- assist in setting benchmarks and goals;
- measure progress towards policy objectives;
- improve understanding of effects of actions;
- motivate improved performance with respect to sustainable development;
- promote consistency and fairness in policy initiatives; and
- make international comparisons.

Notwithstanding general support for a family of macro indicators, caution was expressed regarding the definition and use of indicators. Specifically, concerns were raised that indicators should not be confused with targets which are end points and need to be set through consultative policy-making processes. **As well, it was stated that care should be taken to ensure that indicators are measuring the right thing(s) and not encouraging behaviour that is non-sustainable.**

It was thought that indicators could be used for a variety of purposes and thus several different levels of indicators may be required. Levels include national, regional, sectoral, corporate/organizational and individual. Participants stressed, however, the importance of ensuring that indicators are consistent among and within levels of indicators, particularly if comparisons are to be made. Perhaps most importantly, participants cautioned that there is a need to ensure that indicators are indeed measuring progress towards sustainable development.

2.1 The California and Swedish Experiences

Two guest speakers at the workshop, Cynthia Praul Wright of the California Energy Commission and Hans Rode of Sweden's National Energy Administration, provided data on progress in their jurisdictions towards increased energy conservation and efficiency and decreased dependence on fuels which have high levels of environmental impact. Although their energy strategies have not been couched in terms of sustainable development, nor has either jurisdiction systematically developed a set of economic and environmental indicators related to energy production and use, they were able to show data relevant to indicators being discussed at the workshop.

Their message to workshop participants was that **it is important to set energy goals and to "get on with the job"**. They identified means to accomplish goals including not only firm, reasonable regulations, but more importantly, eliminating perverse incentives and subsidies and building appropriate economic signals for the private sector. Public information and education campaigns to encourage energy conservation initiatives by consumers was also deemed important. They suggested that indicators would be useful to measure progress towards goals.

3.0 SUSTAINABILITY CRITERIA

The policy group at the workshop addressed what criteria should be used to assess what we need to measure through indicators of sustainable development. A preliminary set of criteria were identified. These criteria can be divided into three categories — general, resource and energy specific (Table 1). Participants recognized sustainability criteria as a fundamental component of a policy framework for indicators of sustainable development. These criteria could be useful to all sectors and at all levels to assess the appropriateness and adequacy of indicators. However, there was no attempt to refine the criteria further at the workshop nor any attempt to achieve consensus on it.

Table 1. Preliminary Set of Sustainability Criteria

General	Stabilize population Improve quality of life Reduce material expectations (make do with less) Maintain international competitiveness sustainably Strengthen intellectual capacity and technology availability Enhance employment opportunities
Resource	Respect assimilative capacity, such as ecological thresholds Improve environmental quality Maintain capital stock (natural and man made) Minimize resource waste Reduce resource use
Energy	Improve efficiency of energy use Reduce environmentally harmful emissions Use appropriate energy resource pricing (i.e. full cost and full cycle accounting) Enhance energy supply diversity Increase energy production

4.0 WHAT ARE APPROPRIATE ENERGY INDICATORS?

4.1 Preliminary Set of Macro Indicators (NRT Discussion Paper)

A discussion paper on a preliminary set of national indicators for measuring sustainable development related to energy production and use served as the focus for initial discussions at the workshop. This paper by Marbek Resource Consultants Ltd., was commissioned by NRT in late 1990. The complete paper is provided in Appendix 3. Fifteen indicators were proposed in the Marbek paper, falling into five different categories. A consolidated list of these is found in Table 2.

Several considerations went into Marbek's selection of a preliminary set of indicators. In developing these indicators, two caveats were expressed: there is a lack of agreement as to the definition of sustainable development; and there is difficulty in selecting a manageable set of indicators which reflect the complex nature of our society and economy. Nonetheless, the preliminary set of indicators for energy production and use were chosen with the following criteria in mind:

- They present the bottom line — that is, whenever possible they measure outcomes rather than contributing factors.

- They use data that is available or can be acquired, is credible and is a valid representation of the information it is meant to portray.

- They are useful for both senior decision makers and the general public.

- They focus primarily on environmental, and to some extent economic sustainability, indicators and do not include factors such as social equity which were considered to be more appropriately included in general indicators of sustainable development rather than in those designed specifically for the energy sector.

- As much as possible they are suitable for making international comparisons, although this is not always the case due in part to the current variation in data from country to country.

Furthermore, the author stressed that these are indicators, not targets. He stated that targets for end points, and for the direction and rate of change of indicators would need to be developed separately.

Table 2. Preliminary Set of Indicators

1. QUANTITY OF ENERGY USED
   - 1.1 Energy Use (total energy use in PetaJoule PJ)
   - 1.2 Energy Intensity (energy use per capita, per amount of product, per area of floor space, or per dollar produced)
   - 1.3 Efficiency of Primary to Secondary Conversion (primary/secondary ratio)
2. ENVIRONMENTAL IMPACT
   - 2.1 Greenhouse Gas Emissions (CO_2, N_2O and CH_4 released per unit of energy used)
   - 2.2 Other Air Emissions (SO_x, NO_x, VOC and particulates released per unit of energy used)
   - 2.3 Waste Generation (annual generation of waste per unit of energy used)
   - 2.4 Area of Land Affected by Energy Production (land area committed to production per unit of energy used)
3. LONG TERM RESOURCE AVAILABILITY
   - 3.1 Proportion of Energy Use met by Less Abundant Resources (% of energy use supplied by non-renewable, limited economically recoverable resources)
4. ENERGY PRODUCTIVITY OF THE ECONOMY
   - 4.1 Energy Productivity (Gross Domestic Product per unit of energy used)
5. INDICATORS ASSOCIATED WITH ADDITIONAL PRODUCTION FOR EXPORT
   - 5.1 Net Energy Exports (net volume of energy produced or used to supply export markets)
   - 5.2 Greenhouse Gas Emissions (net amount of CO_2, N_2O and CH_4 released per unit of energy produced or used to supply export markets)
   - 5.3 Other Air Emissions (net amount of SO_x, NO_x, VOC and particulates released per unit of energy produced or used to supply export markets)
   - 5.4 Waste Generation (net annual generation of waste per unit of energy produced or used to supply export markets)
   - 5.5 Area of Land Affected by Energy Production (net land area committed to production per unit of energy produced or used to supply export markets)
   - 5.6 Proportion of Net Exports Met by Less Abundant Resources (% of net energy exports supplied by non-renewable, limited economically recoverable resources)

4.2 Comments Regarding the Preliminary Set of Indicators

Comments on Marbek's preliminary set of indicators were obtained through a panel discussion (for members of the panel see Programme, Appendix 2), small group discussions, and plenary discussions. The overall acceptability of each indicator and specific comments or suggestions are summarized in Table 3. As well, Table 3 provides a list of micro indicators raised by workshop participants which are linked to each of the proposed macro indicators.

Table 3. Comments on Preliminary Indicators

REFERENCE NO. & NAME OF INDICATOR	DEFINITION (UNITS) AND DISAGGREGATION	WORKSHOP SUPPORT	DISCUSSION COMMENTS	EXAMPLES OF RELATED MICRO INDICATORS
1.1 Energy Use	National energy use (PJ) Regional use (PJ) Sectoral use (PJ)	Moderate	▸ energy use per se is not an indicator of sustainable development ▸ unclear what direction indicator should move ▸ useful if related to units of production or service ▸ distinguish between energy used domestically and amount used for export ▸ easy to measure ▸ could report amount of energy demand potentially provided by conservation efforts or demand side management	▸ Annual energy consumption by company or organization ▸ Reductions in annual energy consumption (cost savings, competitive advantage) ▸ Base load and peak load targets of utilities ▸ Amount of fuel purchased and amount internally generated
1.2 Energy Intensity	National energy use per capita (GJ/capita) Regional intensity (GJ/capita) Sectoral intensity (various, depending on sector)	High when related to sectors and units of production or service Low when expressed per capita	▸ national energy use per capita can be useful to track economic reliance on energy but may be misleading in international comparisons ▸ more useful to measure energy efficiency within sectors ▸ increase in energy efficiency desirable (i.e. decrease in energy use per unit of production or service provided) ▸ important to determine net energy content of exports ▸ could instead track relative change in energy use and population (California example)	▸ Energy use per unit of production ▸ Energy used per unit of service provided ▸ Energy used per unit of energy produced ▸ Energy use per household ▸ Energy use per area of floorspace ▸ Energy use per vehicle miles travelled

Table 3. Comments on Preliminary Indicators (Continued)

REFERENCE NO. & NAME OF INDICATOR	DEFINITION (UNITS) AND DISAGGREGATION	WORKSHOP SUPPORT	DISCUSSION COMMENTS	EXAMPLES OF RELATED MICRO INDICATORS
1.3 Efficiency of Primary to Secondary Conversion	Ratio of primary to secondary energy	Low as presently defined Moderate if accounts for full fuel cycle	▸ more useful if look at full fuel cycle i.e. efficiency of conversion at every step in process from when leaves plant to when leaves burner tip ▸ difficult definitional and double counting problems, particularly for electricity ▸ non-energy products (i.e. asphalt, petrochemicals) must be subtracted from national primary energy before ratio is calculated ▸ could show as efficiency staircase for each step of conversion from natural gas resources to electric furnace, to gas furnace or to heat pump (California example)	▸ Co-generated/purchased electricity ratio
2.1 Greenhouse Gases	Greenhouse gases released per TJ of energy used (Tonnes of CO_2 equivalent/TJ)	High at both macro and micro level	▸ should include at least carbon dioxide, nitrous oxide and methane ▸ need to establish credible equivalency definitions (e.g. CO_2 equivalents) for the various gases; may change with science and public opinion ▸ some greenhouse gas emissions are not energy related; important to inventory all sources ▸ measure releases during energy production, transportation and use	▸ Greenhouse gas emissions per unit of energy used ▸ Greenhouse gas emissions per unit of energy (including electricity) produced ▸ Greenhouse gas emissions for various fuel types ▸ Greenhouse gas emissions from individual point sources (plants, vehicles, etc.) ▸ Carbon dioxide emissions in urban areas ▸ Reduction in greenhouse gases (e.g. CFC phaseout)

Table 3. Comments on Preliminary Indicators (Continued)

REFERENCE NO. & NAME OF INDICATOR	DEFINITION (UNITS) AND DISAGGREGATION	WORKSHOP SUPPORT	DISCUSSION COMMENTS	EXAMPLES OF RELATED MICRO INDICATORS
2.2 Other Air Emissions (SO_x, NO_x, VOC, particulate)	Aggregate emissions per TJ of energy used (adjusted tonnes/TJ)	High at both macro and micro level	▸ need to determine relative importance or impact of various emissions ▸ may have difficulty getting consensus on weighting system; weighting may change with science and public opinion ▸ might be preferable to measure individually rather than aggregate ▸ some difficulty in gathering accurate data ▸ measure releases during energy production, transportation and use ▸ not all emissions energy-related; inventory of emissions from all sources important ▸ need to develop consistent approach ▸ links to NO_x/VOC Management Plan need to be identified	▸ Emissions per unit of energy used ▸ Emissions per unit of energy (including electricity) produced ▸ Emissions for various fuel types ▸ Emissions from various point sources (plants, vehicles, etc.) ▸ Emissions in urban areas
2.3 Waste Generation (radioactive, mine tailings, refinery waste, ash, emission control waste, etc.)	Annual generation of wastes per TJ of energy used (adjusted tonnes/TJ) Waste generation by energy source Waste generation by region	Moderate as cumulative index High when expressed by category	▸ weighting or ranking required (i.e. re toxicity, half life, degree of hazard) ▸ may have difficulty developing weighting system; may change with science and public opinion ▸ also important is amount of recycling of waste ▸ most useful at sectoral level or as micro indicator and not necessarily associated only with energy production or use ▸ usefulness questionable in some sectors such as mining which requires high . . . waste production (i.e. spoil piles)	▸ Waste per unit of energy produced or used ▸ Amount of waste by categories (toxic, radioactive, landfill, hazardous etc.) ▸ Amount of waste recycled ▸ Amount of waste disposed safely ▸ Amount of waste lost or unaccounted ▸ Total annual amount of oil spilled ▸ Paper use (total and per employee) ▸ Toxicity level of waste ▸ Return ratio of used products (e.g. oil, containers) ▸ Recyclable or recycled content of product

Table 3. Comments on Preliminary Indicators (Continued)

REFERENCE NO. & NAME OF INDICATOR	DEFINITION (UNITS) AND DISAGGREGATION	WORKSHOP SUPPORT	DISCUSSION COMMENTS	EXCLUDED OR RELATED INDICATORS
2.4 Land Affected by Energy Production	Land area committed to energy production per TJ of energy used (adjusted hectares/TJ) Land area affected by energy source Land area affected by region	Low	▸ not clear indicator of sustainable development ▸ need to weight impacts of different types of energy production (e.g. permanent flooding of land by hydro vs temporary impacts of oil & gas) ▸ need to account for area potentially affected (e.g. by nuclear accident or large oil spill) ▸ need to consider existing uses of land affected (urban vs agricultural vs wildland) ▸ need to weight sensitivity of land affected (tundra vs forest vs grassland) ▸ has limited value at macro level but may be more useful at micro level	▸ Amount of land reclaimed ▸ Relative amount of land displacement for various energy sources (e.g. wind vs coal) ▸ Target of no net loss of land available for non-energy uses ▸ Land required to dispose of waste and value of that land (e.g. recycling desirable if cost of land for landfills high)
3.1 Proportion of Energy Use met by Less Abundant Resources	Non-renewable resources for which economically recoverable reserves will meet current levels of Canadian use of less than 50 years (%) Regional proportion (%) Sectoral proportion (%)	Low as presently defined Moderate if redefined as energy mix or energy diversity	▸ varies with changing technology and market prices (need resource cost curves) ▸ also depends on health of various industry sectors ▸ very problematic to measure; would require frequent readjustments ▸ 50 year time frame arbitrary ▸ not very useful in Canada where abundant energy resources ▸ a more useful indicator might be energy mix or energy diversity (e.g. % contribution of various energy sources); however diversity indicates protection from supply interruption and price increase rather than sustainability ▸ proportion of energy mix met by renewables or sources with low or mitigable environmental impacts may be useful indicator of sustainable development	▸ Proportion of energy supplied by renewables ▸ Amount of substitution by fuels with lower environmental impact

Table 3. Comments on Preliminary Indicators (Continued)

REFERENCE NO. & NAME OF INDICATOR	DEFINITION (UNITS) AND DISAGGREGATION	WORKSHOP SUPPORT	DISCUSSION COMMENTS	EXAMPLES OF RELATED INDICATORS
4.1 Energy Productivity	Real gross domestic product per GJ of energy use ($/GJ) Regional ratio ($/GJ) Sectoral ratio ($/GJ)	Moderate for national use Low for international comparisons	▸ relationship between sustainable development and GDP not clear (e.g. Exxon oil spill increased GDP) ▸ must account for feedback effects within GDP; what affects GDP (e.g. commodity prices) will also affect or be affected by changes in energy use ▸ recommend averaging over several years rather than one year to correct for anomalies in GDP ▸ favoured by policy makers as GDP is best measure of economic activity nationally and able to make international comparisons, however may not lead to behavioural changes ▸ Canada has lowest energy productivity in world partly because of relatively high proportion of energy intensive resource-based industries; may result in displacing production from Canada to other countries without contributing to sustainable development globally ▸ closely linked to energy intensity and energy efficiency (see comments re Indicator 1.2) ▸ need to consider amount of energy used and amount of GDP directed to produce goods for export ▸ may be useful when applied sectorally ▸ could instead track relative change in energy use and gross domestic product (California example)	▸ Value of services provided per unit of energy used ▸ Value of product produced or sold per unit of energy used

Table 3. Comments on Preliminary Indicators (Continued)

REFERENCE NO. & NAME OF INDICATOR	DEFINITION (UNITS) AND DISAGGREGATION	WORKSHOP SUPPORT	DISCUSSION COMMENTS	EXAMPLES OF RELATED INDICATORS
5.1 Net Energy Exports	Net energy exports (PJ) Net exports by energy source	Low	▸ net energy exports per se are not an indicator of sustainable development ▸ unclear what direction indicator should move ▸ more useful indicators would be embodied energy in net exports or efficiency of energy production for export	▸ No examples provided
5.2- 5.5 Environmental Impacts of Net Energy Exports	Same as indicators 2.1-2.4 in concept however actual data would be different as it would exclude impacts of energy use	Moderate	▸ same comments as for Indicators 2.1-2.4 ▸ focus on pollutants that are important internationally	▸ No examples provided
5.3 Net Exports met by Less Abundant Resources		Low	▸ some comments as for Indicator 3.1	▸ No examples provided

General comments on the complete set of indicators follow.

a) Support for Preliminary Indicators

Workshop participants agreed that the preliminary set of indicators provided a useful basis for discussion and that work will be needed to develop a second generation set of indicators. Some indicators were better received than others, but improvements were suggested for many of the proposed indicators. Some were considered more useful at the sectoral or corporate level than at the national or macro level.

The two indicators receiving the highest level of support were those of sectoral energy efficiency (energy used per unit of product or service provided), and air emissions and waste (by category). Indicators of total energy use and diversity of the energy mix received moderate support. Participants felt it useful to know this information, but stated that these data by themselves were not indicators of sustainable development. Efficiency of energy conversion for the full fuel cycle also received moderate support as an indicator although it was cautioned that there may be difficult definitional and double counting problems.

There was a mixed reaction to proposed national indicators of energy intensity (energy use per capita) and energy productivity (GDP per unit of energy used). Some participants, particularly in the policy group, thought these two indicators could be useful within Canada to track economic reliance on energy. However, most participants, including energy suppliers and users, agreed these two indicators were inappropriate for international comparisons because they inaccurately portray Canada's performance regarding energy efficiency. This is because a large part of Canada's economy, particularly our export market, is tied to energy-intensive development of natural resources.

However, if these two indicators were used to evaluate trends and rates of change, they would be acceptable. The participants only disagreed with these indicators being used for direct comparisons among nations which could portray Canada as a profligate energy user when the cause of the disparity flows from different national economic bases. In the aggregate Canada could look bad, since forestry, agriculture, mining, and petroleum production and processing form the base of the economy. Less energy intensive economies based on manufacturing, services, and production for the domestic market would appear "better" because different activities are in fact being measured for energy use without examining the efficiency with which that energy is applied.

There was little support for an indicator based on the amount of land affected by energy development. There were questions raised about the usefulness of this indicator because of the variabilities regarding the degree, longevity, and risk of impacts. As well, there was little — if any — support for measuring the proportion of energy use met by less abundant resources because of high variability due to changing technology and market prices.

b) Energy Exports

There was moderate support for the preliminary indicators related to export proposed by Marbek. No agreement was reached on how to define and report energy export indicators.
Some participants argued that what is important is the overall level of energy production, efficiency of production and resulting environmental impact(s), whether energy is produced for export or not. They stated Canada did not need separate indicators for energy exports.

Others argued that because Canada provides energy and other natural resources to the rest of the world, Canada should explicitly state the amount of energy use, efficiency of production, and environmental impact(s) (e.g. greenhouse gas emissions) related to that export. Failure to do so could result in a distorted picture of Canada's performance regarding sustainable development.

Still others argued that if energy embodied in products destined for export had separate indicators, the energy embodied in imports should also be identified and net energy imported or exported used as the basis for these export indicators.

c) Additional Indicators

Several participants stated that the proposed set of indicators is based on available data and is not a complete list. The need for a more comprehensive list and supporting data was identified. Two additional areas where suggested:

- Water Quality and Use — e.g. water contaminants, water consumption, efficiency of water use, amount of water recycled;

- Socio-Economic Factors — e.g. jobs and other spin-off benefits provided by energy production and environmental clean-up, cost of environmental clean-up, economic health

of industry (e.g. cash flow, return on investment), intellectual capital, technology availability, quality of life considerations, human health considerations.

It was not clear from the discussion whether participants considered these indicators important at the national (macro) level or at the corporate/organization (micro) level or both.

d) Linking Micro Indicators with Macro Indicators

Participants identified about 50 micro indicators currently in use or being considered by corporations or organizations. The majority of these indicators could be linked to the proposed macro indicators. These obvious linkages confirm that there is a "real world" foundation for many of the preliminary macro indicators (Table 3). Those corporate/organizational level indicators which could not be linked to a proposed national indicator suggested a need for additional macro indicators (see sections on Additional Indicators and Contributing Factors). There were no indicators identified at the corporate/organization level that could be linked to national indicators dealing with energy export (Indicators 5.1-5.3).

It was suggested by several participants that attempts to systematically aggregate micro indicators from individual companies or organizations into macro indicators would pose unrealistic accounting problems. Micro indicators currently are in their very early formative stages and they are not yet standardized nor widely adopted within industry sectors. As well, many organizations are currently focusing on the actions required to integrate environmental considerations into business planning rather than on actual outcomes, which is the focus of the proposed macro indicators. Nevertheless, participants agreed that macro indicators should be sensitive to general changes measured through micro indicators and act as a national gauge of actions towards sustainable development at the corporate or organization level. The question was raised as to how to measure efficiency nationally, by product or sector. A private sector energy user participant in the government-industry program called Canadian Industry Program for Energy Conservation (CIPEC) suggested that CIPEC might be an existing avenue for accomplishing this.

e) Indicators of Contributing Factors

Many participants over the course of the two-day workshop identified a need to measure factors contributing to sustainable development outcomes rather than only the outcomes themselves, particularly at the micro level. Contributing factors were defined as the actions or policies required to achieve sustainable development. It was argued that indicators of contributing factors are more likely to motivate changes in behaviour at the micro level than are indicators of outcomes. Examples of contributing factors provided by workshop participants include:

- market penetration of energy efficient products
- market penetration of emission reducing technologies
- acceptance and implementation of procurement policies, such as energy efficiency and waste reduction
- acceptance and implementation of energy efficiency audits
- acceptance and implementation of environmental audits
- acceptance and implementation of demand side management programs by electric utilities
- investments in research and development
- acceptance and implementation of full cost and full cycle accounting methodologies

5.0 NEXT STEPS AND FUTURE DIRECTIONS

Workshop participants were asked to identify and discuss future directions in developing indicators of sustainable development in energy production and use. Key suggestions arising from these discussions follow.

5.1 Set National Framework

All small groups identified a need to develop a coherent national policy framework to help determine indicators of sustainable development. This would apply to all levels of indicators — national, regional, sectoral, corporate/organizational and individual. As part of this recommendation, participants recognized the importance of developing sustainability criteria which could be used to determine appropriateness and adequacy of indicators. This work could build on the sustainability criteria proposed by the policy group at the workshop and on other related work currently being done by the NRT.

The need to develop clearly defined goals or targets for sustainable development also was identified by workshop participants. Indicators could then be used to assess progress towards these goals. Noteworthy, however, is the widespread concern expressed about the process for defining criteria and goals. Participants stressed that definition of criteria and goals should not occur unilaterally or through bilateral negotiation but rather **through a consultative process involving all affected sectors.**

5.2 Continue to Develop National Indicators

There was solid support for having a set of national indicators of sustainable development related to energy production and use. All groups identified a need to more clearly define the preliminary set of energy indicators as discussed at the workshop. This would include reassessing and revising the indicators of energy intensity and productivity to place more emphasis on indicators of energy efficiency. Participants strongly suggested there is some urgency for accomplishing this so that it could be included as part of Canada's position for the United Nations Conference in Brazil in June, 1992. There was general agreement that indicators of water quality and socio-economic indicators needed to be factored into developing a comprehensive set of indicators.

5.3 Encourage Development of Micro Indicators

All small groups recognized the importance of developing micro indicators, particularly within corporations and organizations. It was suggested that these are the indicators most likely to motivate changes in individual and corporate behaviour and ensure accountability. Although workshop participants proposed few specific pilot projects on micro indicators, most of the energy suppliers and users represented at the workshop indicated they are beginning to define and develop performance indicators related to environment and sustainable development. Another suggestion to assist the development of micro indicators was for an ongoing exchange of information on indicators among the national, provincial and territorial round tables, government agencies (federal, provincial, municipal), industry and public interest organizations, such as consumer and environmental groups. One specific recommendation was to provide NRT's report on this workshop to the parties mentioned above and another was to set up a centralized information base on sustainable development indicators. Several participants stated that the workshop helped provide a context for their work on indicators and stimulated their thinking on the matter. The workshop also set the stage for future consultation.

5.4 NRT Role in Development of Sustainable Development Indicators

The National Round Table on the Environment and the Economy (NRT) was identified by all small groups as the body which should help provide the policy framework for indicators, promote the development and use of indicators and collaborate with other groups better suited to do the technical work. NRT is structured to draw on the expertise of several federal government departments, including the Departments of Environment, Finance, and Energy, Mines and Resources. Moreover, NRT is structured to include representatives of industry and environmental organizations, whose advice and support is essential. Also, NRT has ties to provincial and territorial round tables which provide avenues for public consultation. Finally, NRT advises the Prime Minister. Political support for the concepts of sustainable development is essential in setting the policy framework for national indicators.

APPENDIX 1

MEASURING SUSTAINABLE DEVELOPMENT: ENERGY PRODUCTION AND USE IN CANADA

Workshop Participants

Name/Nom	*Organization/Organisme*	*Location/Lieu*
Ed Bain	*Nova Scotia Department of Energy*	*Halifax, Nova Scotia*
Jay Barclay	*Energy, Mines and Resources*	*Ottawa, Ontario*
Grant Billing	*North Canadian Oils Ltd.*	*Calgary, Alberta*
Cheryl Bradley	*Western Environmental and Social Trends Inc.*	*Calgary, Alberta*
Liza Campbell	*NRT Secretariat*	*Ottawa, Ontario*
Don Dabbs	*Calgary Chamber of Commerce c/o Concord Environmental*	*Calgary, Alberta*
Len Delicaet	*Ernst and Young*	*Toronto, Ontario*
Ron Edwards	*Department of Finance*	*Ottawa, Ontario*
Jason Edworthy	*Nowester Energy Systems Ltd.*	*Calgary, Alberta*
Dawn Farrell	*TransAlta Utilities Corporation*	*Calgary, Alberta*
Charlie Ferguson	*Inco Ltd.*	*Toronto, Ontario*
Jane Hawkrigg	*Jane Hawkrigg Enterprises Ltd.*	*Baie D'Urfe, Quebec*
Tony Hodge	*University of McGill*	*Montreal, Quebec*
Helen Howes	*Ontario Hydro*	*Toronto, Ontario*
Pierre Marc Johnson	*NRT*	*Montreal, Quebec*
Jim Johnston	*Canadian Renewable Fuels Assoc.*	*Guelph, Ontario*
Diane Keefe	*Canadian Utilities Ltd.*	*Edmonton, Alberta*
Mike Kelly	*NRT Secretariat*	*Ottawa, Ontario*
Mel Kliman	*McMaster University*	*Hamilton, Ontario*
Jean Etienne Klimpt	*Hydro Quebec*	*Montreal, Quebec*
Linton Kulak	*Shell Canada*	*Calgary, Alberta*
Gordon Lambert	*Esso Resources Canada*	*Calgary, Alberta*
David Lightfoot	*Petromont*	*Montreal, Quebec*
Jim MacNeill	*NRT*	*Ottawa, Ontario*
George Matheson	*Marbek Resource Consultants*	*Ottawa, Ontario*
Kerry Mattila	*Canadian Petroleum Products Institute*	*Ottawa, Ontario*

Neil McIlveen	Energy, Mines and Resources	Ottawa, Ontario
Lynn Morrow	Municipality of Toronto	Toronto, Ontario
Ken Ogilvie	Canadian Environmental Advisory Committee	Ottawa, Ontario
John Peacey	Noranda Minerals Inc.	Point Claire, Quebec
Juri Pill	Toronto Transit Commission	Toronto, Ontario
Wayne Pushka	Canada Mortgage and Housing Corporation	Ottawa, Ontario
Tony Reinsch	Canadian Energy Research Institute	Calgary, Alberta
Mike Robertson	PetroCanada	Calgary, Alberta
Hans Rode	National Energy Administration	Sweden
Kenneth Rossi	Ford Motor Company of Canada	Oakville, Ontario
David Runnalls	Institute for Research on Public Policy	Ottawa, Ontario
Krishna Sahay	Department of Finance	Ottawa, Ontario
Robin Sinha	Canada Mortgage and Housing Corporation	Ottawa, Ontario
Tim Taylor	PetroCanada	Calgary, Alberta
Steve Thompson	NRT Secretariat	Ottawa, Ontario
Thorn Walden	Energy Resources Conservation Board	Calgary, Alberta
Alain Webster	University of Quebec	Montreal, Quebec
Leslie Whitby	Environment Canada	Hull, Quebec
Fraser Wilson	Ernst and Young	Toronto, Ontario
John Woodruffe	Shell Canada	Calgary, Alberta
Barry Worbets	Husky Oil Limited	Calgary, Alberta
Cynthia Praul Wright	California Energy Commission	Sacramento, California U.S.A.

APPENDIX 2

Measuring Sustainable Development:
Energy Production and Use in Canada

February 28 - March 1, 1991 Montreal, Quebec
Delta Montreal, 475 avenue President Kennedy

SUMMARY AGENDA

Thursday February 28th

7:30 a.m.	*Registration and Continental Breakfast*
8:30 a.m.	*Introduction*
9:30 a.m.	*National Energy Indicators* *Overview of Discussion Paper* *Panel Discussion* *Plenary Discussion and Questions* *Small Group Discussions and Working Lunch* *Plenary Discussion and Synthesis*
3:15 p.m.	*Practical Links Between Macro and Micro Indicators* *Concurrent Workshops* *Plenary Progress Report*
7:30 p.m.	*Reception and Dinner*

Friday March 1st

7:30 a.m.	*Continental Breakfast*
8:30 a.m.	*Summary of Key Issues and of Progress*
	Next Steps *Concurrent Workshops* *Plenary Discussion and Concluding Remarks*
1:00 p.m.	*Lunch*

Detailed Agenda

Thursday February 28th

7:30 a.m. — **Registration and Continental Breakfast**

INTRODUCTION

8:30 a.m.

Workshop Chair: Pierre Marc Johnson, Vice - Chair, NRT

Opening Remarks: Jim MacNeill, Senior Fellow, Environment and Sustainable Development Programme, Institute for Research on Public Policy, Ottawa

Workshop Goals and Outcomes: Fraser Wilson, Partner, Environmental Management, Ernst & Young

NATIONAL ENERGY INDICATORS

9:30 a.m.

Overview of Discussion Paper: George Matheson, Marbek Resource Consultants, Ottawa

Panel Discussion:
Moderator: Pierre Marc Johnson

Panel:

Tony Reinsch, Canadian Energy Research Institute

Mike Robertson, PetroCanada

Charlie Ferguson, INCO

Cynthia Praul Wright, California Energy Commission, U.S.A.

David Runnalls, Institute for Research on Public Policy

George Matheson, Marbek Resource Consultants

Break for Refreshments

Detailed Agenda

Thursday February 28th cont'd.

NATIONAL ENERGY INDICATORS cont'd.

Plenary Discussion: Questions from the Floor
Moderators: Pierre Marc Johnson

11:30 a.m. **Small Group Discussions,** including,
12:30 p.m. **Buffet Style Working Lunch**
Facilitators: Jay Barclay, Cheryl Bradley, Kevin Brady, Jane Hawkrigg, Mike Kelly, Ken Ogilvie, Steve Thompson

1:30 p.m. **Plenary Discussion & Synthesis:**
Moderators: Pierre Marc Johnson and Fraser Wilson

Break

PRACTICAL LINKS BETWEEN MACRO AND MICRO INDICATORS

3:15 p.m. **Concurrent Workshops**
Facilitators: Jay Barclay, Cheryl Bradley, Jane Hawkrigg, Mike Kelly

1. Energy Suppliers
2. Energy Users
3. Policy Issues

5:15 p.m. **Plenary Progress Report**

6:00 p.m. **Adjournment**

7:30 p.m. **Reception and Dinner**
Guest Speaker: Hans Rode,
National Energy Administration, Sweden

Detailed Agenda

Friday, March 1st

7:30 a.m.	*Continental Breakfast*
	NEXT STEPS
8:30 a.m.	***Plenary session**: General Discussion of Key Issues and Direction for Concurrent Workshops on Next Steps* *Moderators: Pierre Marc Johnson and Fraser Wilson*
	Break
9:45 a.m.	***Concurrent Workshops*** *Facilitators*
11:45 a.m.	***Plenary Report and Concluding Remarks*** *Moderators: Jim MacNeill and Fraser Wilson*
1:00 p.m.	***Lunch***

APPENDIX 3

This paper was prepared for the National Round Table on the Environment and the Economy's Workshop on ***Measuring Sustainable Development: Energy Production and Use in Canada.***

The views expressed in this discussion document are not necessarily endorsed by the National Round Table on the Environment and the Economy.

RATIONALE AND PRELIMINARY FAMILY OF NATIONAL INDICATORS FOR SUSTAINABLE ENERGY PRODUCTION AND USE

A DISCUSSION PAPER

Submitted to:

The National Round Table on the Environment and the Economy

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August 1990

Marbek

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SECTION 1. INTRODUCTION

1.1 Background

The National Round Table on the Environment and the Economy (NRTEE) is developing performance indicators for sustainable energy production and use. As part of this process, the Round Table has commissioned a series of papers, of which this document is one. Specifically, this paper considers options for a preliminary family of macro-level, national energy indicators directed at senior decision/policy makers and the general public.

The pages that follow are intended to be a discussion starter. As such, this paper has deliberately been kept brief, and does not seek to address or resolve all issues relating to indicators development. Moreover, the paper does not address issues that are to be covered in companion documents being prepared for the NRTEE (specifically the issues of an overall conceptual framework, data availability, and the role of energy in economic performance and sustainable development).

Given the strict time and budget constraints under which this paper was prepared, and the fact that it is only a first step in a longer process, no external or peer review was undertaken prior to submission. Instead, the development of this paper consisted of an initial "brainstorming" meeting involving Marbek personnel, outside advisors, and NRTEE representatives; a limited literature review; preparation of a "Concepts Paper" for discussion at a second "brainstorming" meeting; and finally preparation of this paper.

1.2 Energy Indicators

It is widely accepted that we must transform our society into one that operates in accordance with the principles of sustainable development. Sustainable development indicators are conceived as a means of measuring our progress towards this goal (ie. the goal of bringing about a process of sustainable development).

The task of developing such indicators, however, is made complex by many factors, the most significant being the lack of agreement as to what sustainable development is (except at the most abstract level, as embodied in the Brundtland definition) and the challenging (if not impossible) task of selecting a manageable set of indicators that reliably reflect the extraordinarily complex nature of our society and economy.

Given this, it is useful to attempt to develop indicators for a more specific topic: sustainable energy production and use. In doing so it must be recognized that movement towards more sustainable energy production and use is only a component of progress towards the goal of sustainable development.

As is noted above, this paper focuses on "macro level" indicators; that is, indicators that suggest how Canada as a whole, or major elements of Canadian society, are doing with regard to the sustainability of energy production and use. This implies relatively aggregated data (which can be problematic in a country as large and diverse as Canada).

SECTION 2. GUIDELINES: CONSIDERATIONS IN THE SELECTION OF INDICATORS

Prior to identifying specific indicators, it is necessary to define the scope of discussion. For this purpose, the following guidelines are suggested:

2.1 Definition of an Indicator

The term "indicator" has come to mean different things to different people. On the one extreme, "... its meaning appears to have been expanded to the point where it is commonly used as a synonym for data."[1] Similarly, the term has found widespread usage in relation to state-of-the-environment reporting, where the collected data are often referred to as indicators.

For the purposes of this paper, however, a narrower definition has been adopted. Specifically, our indicators consist of only a few salient pieces of data which provide a general picture of the sustainability of energy production and use, as opposed to a detailed record. The difference between this definition of "indicator" and the broader usage is one of degree, not of kind, but it is an important distinction.

2.2 "Bottom Line" Indicators

The needs of the primary audiences (senior decision/policy makers and the general public) imply a need for indicators that present the "bottom line" -- that is, progress towards the goal of sustainable development rather than detailed analysis of contributing factors.

This is an extremely important point. There is a tendency to expect too much of indicators. For instance, many writers suggest that indicators should reflect the impact of specific policy initiatives. At least for the indicators under discussion here, we argue that this is both unrealistic and inappropriate. Indicators can tell us how we are doing, but should not normally be expected to tell us why a particular outcome has arisen. In other words, indicators are meant to be indicative rather than explanatory; they are not meant to be an analytical tool. Where indicators point to a failure to achieve a desired outcome, more detailed analysis to indicate the source of the failure is implied. Such analysis would no doubt require baseline and current data beyond that captured in the indicators as such.

2.3 Outcomes, Not Factors

Given the "bottom line" orientation just referred to, we believe the focus should be on indicators that measure outcomes directly (eg. energy use per capita) rather than those that measure contributing factors (eg. the penetration of specific technologies, government spending on conservation, etc.). That said, indicators that deal with such factors can be useful surrogates when data relating to outcomes is unavailable (a situation that is most likely to arise when relatively disaggregated data is required).

2.4 International Comparisons

The ability to make international comparisons is important as a means of making the indicators engaging, but is problematic. Such comparisons depend upon the availability of similar types of data in all countries with which comparisons are to be made, yet data availability varies from country to country. Moreover, even apparently similar data may not be directly comparable. Even where the data is technically comparable, structural differences in economies between countries may make comparison of absolute values inappropriate.

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[1] Gélinas, Ron and Jan Slaats (1989). *Selecting Indicators for State of the Environment Reporting (Draft)*. SOE Reporting Branch, Environment Canada.

Thus, while the ability to make international comparisons is desirable, it should not be a requirement in the development of the first generation of energy indicators (see point 2.8 below). In the longer term, comparisons of rates of change in key indicators will likely be more meaningful than absolute values, at least in the case of macro-level data.

2.5 Indicators or Indices?

It is theoretically possible to combine or aggregate data from a series of indicators to produce a dimensionless index of sustainability (similar in some respects to the Dow Jones industrial average or to air pollution indices). While the development of a single index of the sustainability of energy production and use is an attractive idea in principle, it too is problematic in practice. First, it is debatable whether a reasonable index of this sort could be defined (and unlikely that such an index, if defined, would have sufficient credibility to be useful). Moreover, unlike most common indices, "sustainability of energy production and use" is an abstract concept that is likely to be less well understood than its component parts. Finally, as is pointed out by various authors, the methodological challenges in aggregation, such as the risk of double counting, are significant.

In view of all of the above, the goal in developing the first generation of energy indicators should not include the development of an aggregated index.

2.6 Indicators, Not Targets

Energy indicators should, as has been discussed, indicate how we are doing with regard to sustainability of energy production and use. Over time, indicators should not only tell us "where we are", but also how quickly we are moving towards or away from the general goal of sustainable development. It is equally true that indicators alone can not tell us whether the current situation or the rate of change is satisfactory. In order to make this judgement, targets need to be established -- targets for both the end point and the rate of change.

That said, the establishment of targets is clearly a separate issue from the development of indicators. As such, the question of targets is not discussed further in this paper.

2.7 Data Availability and Credibility

At the risk of stating the obvious, it is worth noting that the indicators selected must meet a number of criteria, including the following:

- The required data must be available or it must be reasonable to assume that the data could be acquired
- The data must be inherently credible (scientifically sound)
- The data must be a reliable indicator of larger trends (ie. it must provide meaningful information on the characteristic it seeks to represent).

Clearly, the indicators selected must also be readily understood by the target audiences -- decision/policy makers and the general public. To the degree they are understood, the indicators will inform, influence decision-making, and enhance the accountability of decision-makers regarding progress towards sustainability. The general point -- the need for the indicators to be understandable -- reinforces the need for simplicity suggested by several of the points previously made.

2.8 An Iterative Process

Finally, the development of the family of energy indicators should be an iterative process, improving over time. Demanding perfection prior to initial adoption would likely ensure that no proposals are ever accepted. The history of the development of macro-level environmental

indicators (a complex but probably simpler task than developing indicators of sustainability) supports this conclusion: although considerable effort has been applied, there are few results.[2]

Development of a family of indicators on an iterative basis, on the other hand, would allow data collection and publication to begin in the near term, in parallel with the development of the next, improved generation of indicators. This process produces tangible results in a reasonable time frame, and allows actual experience with the first generation of indicators to shape future generations.

SECTION 3. A FRAMEWORK FOR SELECTING ENERGY INDICATORS

Based in part on the guidelines presented above, this section outlines a framework for a family of indicators.

3.1 Sustainable Development

"Sustainable development" is a larger concept than "environmentally and economically sustainable development", in that the latter does not necessarily consider social, cultural, ethical, or political sustainability. Thus, it could be argued that indicators of sustainability in energy production and use should look beyond the economic and environmental dimensions to consider factors such as social equity. However, it is our view that indicators that address such issues are more appropriately and practically associated with indicators of sustainable development in general, and as such we do not propose such indicators for energy specifically. In other words, our indicators focus on the narrower topic of environmental and economic sustainability of energy production and use.

While the economic and environmental dimensions of sustainability are interlocked, organizationally it is useful to consider these two aspects separately.

3.2 Environmental Sustainability

First, we believe that two generic characteristics of energy production and use must be considered in order to measure *environmental* sustainability (or, more precisely, changes in each of these two characteristics must be considered in evaluating progress towards the goal of environmentally sustainable energy production and use). The characteristics are:

1) Quantity of energy produced and used
2) Environmental impact per unit of energy production or use.

It is our view that, over time, changes in the data showing declining energy use and declining environmental impact per unit would clearly indicate progress towards sustainability, provided the economic indicators outlined below show similar trends.[3] We therefore propose to develop indicators to measure the two characteristics; our proposed indicators are listed in Section 4.

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[2] See, for instance, VHB Research & Consulting (1989). *Indicators and Indices of the State of the Environment.* Prepared for Environment Canada and Statistics Canada. The authors also note that "...the traditional approach to developing environmental indicators has been too concerned with coverage and not enough with convenience, too much with theory and not enough with utility."

[3] This statement should not be seen as implying that the goal of sustainable development requires energy use to decline, ultimately, to zero. What the statement does imply, however, is that our energy consumption could be reduced significantly without imposing unacceptable costs, and that doing so would enhance sustainability.

3.3 Economic Sustainability

The characteristics which must be considered in order to measure the economic sustainability of energy production and use are less obvious than those for environmental sustainability. As a point of departure, we would argue that:

- Macro-level indicators of the performance of the economy as a whole, while theoretically pertinent to the issue at hand, are nevertheless an inappropriate component of the required family of energy indicators. First, traditional economic indicators do not measure sustainability. Second, even if adequate indicators of sustainability of the economy as a whole were to be developed, it does not necessarily follow that they would provide useful guidance concerning the sustainability of any particular component of the economy (such as energy production and use).

- At the other end of the spectrum, indicators that focus on the health of the energy industry would also be an inappropriate component of the family of indicators -- most fundamentally because *apparent* health of the industry is influenced by a host of factors that are unrelated to long-term economic sustainability (such as the macro-economic policies of the government of the day or politics in the Middle East).

Implicit in the above two points is the suggestion that the required indicators of economic sustainability should focus on the resource base supporting energy production and use, rather than on the somewhat volatile industry and economy that is built on that base. Specifically, we suggest that two generic characteristics be considered for indicator development:

1) Long term resource availability
2) Energy productivity of the economy.

These two characteristics require elaboration. Long term resource availability refers to the "life expectancy" of the energy sources in use. In principle it should reflect characteristics such as reserves of non-renewable resources, extent of use of renewable resources, and less tangible variables such as national self sufficiency. Energy productivity of the economy refers to the economic "mileage" we derive from our energy resources.

It is our view that, over time, changes in the data showing increases in long term resource availability and in energy productivity of the economy would indicate progress towards sustainability in energy production and use, provided the environmental indicators outlined above show similar trends. We therefore propose to develop indicators to measure these two characteristics; our proposed indicators are listed in Section 4.

3.4 Summary and Qualifications

In summary, it is suggested that the proposed family of indicators of environmentally and economically sustainable energy production and use could consist of indicators that measure: the quantity of energy produced and used; the environmental impact per unit of energy production or use; long term resource availability; and the energy productivity of the economy.

These characteristics are somewhat different than those suggested by the Round Table as an initial list for consideration in the development of the indicators. However, the characteristics suggested here incorporate the Round Table suggestions, albeit within a revised and expanded framework.

It is, of course, possible to debate whether our proposed characteristics adequately describe sustainability, but a more significant problem arises in the attempt to find indicators that adequately address certain of the characteristics. This is the focus of the next section.

SECTION 4. SELECTION OF INDICATORS

For each of the four characteristics outlined above, this section includes an exhibit that provides:

- A brief discussion of key conceptual issues
- A listing of recommended indicators
- A short "shopping list" of other possible indicators
- A list of selected methodological issues requiring consideration.

For each of the recommended indicators, a series of options for disaggregation is also presented. There is no intended implication that all of the listed options should be a part of the "family" of indicators; the degree to which disaggregated data is required deserves further consideration.

Canada imports and exports large quantities of energy, which complicates development of a number of the required indicators. For clarity of presentation, therefore, the four exhibits just described focus on domestic energy use and on that portion of our energy production that serves domestic needs. A fifth exhibit considers indicators that are concerned with the portion of our production that is exported. (It is worth noting that the policy responses to unsustainable domestic energy use may be entirely different from the responses to unsustainable energy exports; separating export-related indicators in this way might therefore be considered logical as well as convenient.)

EXHIBIT 1

CHARACTERISTIC: QUANTITY OF ENERGY PRODUCED AND USED[4]

DISCUSSION:

As noted above, this exhibit focuses on domestic energy usage; the question of additional production for export is addressed in Exhibit 5.

Two specific issues warrant discussion:

1. Primary vs. secondary energy usage

The term primary energy refers to energy commodities at the point of production, whereas secondary energy refers to energy as delivered to the point of use. In principle, indicators of energy usage could use either primary of secondary energy data.

In part because there are methodological issues associated with how primary energy is calculated, but more importantly because data relating to energy at the point of use is likely to be more meaningful to most users of the indicators, use of secondary energy data is recommended (Indicators 1.1 & 1.2 below). However, because the relationship between primary and secondary energy is not constant (overall, the efficiency of the conversion is declining), it is also appropriate to include an indicator that addresses the primary/secondary ratio (Indicator 1.3 below).

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[4] This characteristic encompasses two of the areas identified by the NRTEE for indicator development (efficient end use and efficient conversion from source to end use).

2. Intensities

In addition to indicators that reflect total energy use (Indicator 1.1 below), it is useful to include indicators that reflect energy intensity (for instance, energy use per capita). Such intensities (Indicator 1.2 below) provide an improved picture of our energy use, but have an inherent limitation. Specifically, they do not measure changes in the variable used to define the intensity. For instance, if energy use per passenger-kilometre was selected as an indicator for the transportation sector, it would tell us something about the technical efficiency of our transportation system but not about changes in the number of passenger-kilometres (which could have as much impact on sustainability as technical efficiency).

This problem is inherent in the use of intensities as indicators, but we do not believe it precludes their use. It does imply, however, that any intensities chosen must be carefully considered. For instance, for the present purposes, a more appropriate measure of intensity in the passenger transportation sector might be energy use per capita. This indicator tells us how we are doing, overall, in the sector -- which, as noted above, energy use per passenger-kilometre does not. It is true that energy use per capita does not tell us why changes are occurring, but we have argued in Section 2.2 that we should not expect our indicators to do so.

In fact, it is appealing to consider the use of per capita data to indicate intensities in all energy using sectors, in part because this would conceptually simplify the family of indicators. However, energy use in some sectors is heavily influenced by import/export activity; in these cases, per capita indicators have the potential to mislead (unless the data is manipulated to correct for this factor).

(Note: One commonly used intensity figure relates energy use to GDP. This relationship is addressed in Exhibit 4.)

PROPOSED INDICATORS:

INDICATOR 1.1:	**ENERGY USE**
Indicator:	National energy use (GJ)[5]
Disaggregation:	Regional use (GJ)
	Sectoral use (GJ)
INDICATOR 1.2:	**ENERGY INTENSITY**
Indicator:	National energy use per capita (GJ/capita)
Disaggregation:	Regional intensity (GJ/capita)
	Sectoral intensity:
	. Residential (GJ/capita)
	. Transportation (GJ/capita (passenger) and GJ/tonne-kilometre (freight))
	. Commercial (GJ/m^2 floor space)
	. Industrial (GJ/dollar produced)
INDICATOR 1.3:	**EFFICIENCY OF PRIMARY/SECONDARY CONVERSION**
Indicator:	National secondary/primary ratio (dimensionless)
Disaggregation:	Secondary/primary ratio by energy source (dimensionless)

[5] For convenience, gigajoules (GJ) are used as the standard energy unit throughout this paper.

OTHER POSSIBLE INDICATORS:

1. A number of indicators that do not relate directly to energy usage are sometimes proposed (for instance, penetration rates for energy conserving technologies, program expenditures, etc.). No such indicators are proposed here, given the premise outlined in Section 2.3 of this paper and the fact that available energy data would provide adequate and more pertinent information to the intended audience.

2. For Indicator 1.2: Various other disaggregated indicators are available, such as sectoral energy use per capita for the sectors where this is not already proposed (but see discussion above); GJ/household for the residential sector; etc.

SELECTED METHODOLOGICAL ISSUES:

1. Valuing of various energy sources in the calculation of primary energy (for instance, in such calculations hydroelectricity has traditionally been treated as if the power had been generated from coal -- a practice many analysts consider questionable)

2. Validity of data for both primary and secondary energy.

EXHIBIT 2

CHARACTERISTIC: ENVIRONMENTAL IMPACT PER UNIT OF ENERGY PRODUCED/USED

DISCUSSION:

As noted above, this exhibit focuses on domestic energy use; the question of the impacts of *additional* production for export is addressed in Exhibit 5.

Of the four characteristics for which indicators are proposed, environmental impact per unit of energy used is perhaps the most complex. Impacts to be considered include wastes produced, emissions, land-use issues, ecosystem stresses, etc.; these impacts must be considered for all stages of energy production and use.

As a result of this complexity, our recommended approach to the selection of indicators is to identify a set of major impacts which, because of their significance, could be considered indicative of overall impact. This approach has the virtue of reasonable simplicity, but conversely introduces the possibility of misrepresentation, given the wide range of environmental impacts that are necessarily ignored. (Note: Two alternative approaches were considered; see "Other Possible Indicators", below.)

An important methodological issue must be considered, whatever general approach is adopted. As is suggested above, the indicators selected must in principle reflect both the impacts of using energy and the upstream impacts of producing and delivering it. However, some of the upstream impacts occur outside Canada (for those energy commodities that we import), while some of the impacts that occur inside Canada are not attributable to Canadian energy use (for those commodities that we export).

The implied data problem is more apparent than real, however. While *aggregate* production impact data will not necessarily reflect accurately the impacts associated with domestic use, the required indicator deals with impact *per unit* of energy. Canadian averages for impacts

per unit of production can therefore be used as approximations in the suggested indicators. (This implies acceptance of two simplifying assumptions: that the average production impacts of energy produced for export and for domestic use are the same, and that average impacts of production are the same inside and outside Canada. These assumptions can be challenged, but we believe they are appropriate for at least the first generation of indicators.)

PROPOSED INDICATORS:

Selection of the "set of major impacts which...could be considered indicative of overall impact" requires more consideration than can be given in this short paper. The following is therefore a preliminary list of possibilities rather than a firm recommendation:

INDICATOR 2.1	GREENHOUSE GASES
Indicator:	Greenhouse gases released per GJ of energy used (Tonnes of CO_2 equivalent/GJ)
Comment:	Must account for releases during production, transportation, and use; should include at least CO_2, N_2O, and methane data, adjusted to CO_2 equivalence (vis a vis impact on global warming)
INDICATOR 2.2	OTHER AIR EMISSIONS (SO_x, NO_x, VOC, particulate, other?)
Indicator:	Aggregate emissions per GJ of energy used (Adjusted tonnes/GJ)
Comment:	Must account for releases during production, transportation, and use; weighting of various emissions is required.
INDICATOR 2.3	WASTE GENERATION (High and low level radioactive waste, mine tailings, refinery waste, ash, emission control wastes, etc.)
Indicator:	Annual generation of wastes per GJ of energy used (Adjusted tonnes/GJ)
Comment:	Must account for wastes generated during production, transportation, and use, but production wastes will predominate; weighting of various wastes is required.
INDICATOR 2.4	AREA OF LAND AFFECTED BY ENERGY PRODUCTION
Indicator:	Land area committed to energy production per GJ of energy used (Adjusted hectares/GJ)
Comment:	Weighting of different energy related land uses is required, based on nature of use (e.g. pipeline vs open pit mine) and sensitivity of land (e.g. tundra vs urban)

DISAGGREGATION: Each of the above indicators could, in principle, be disaggregated by energy source and/or regionally (or bioregionally).

OTHER POSSIBLE INDICATORS:

1. Alternatives or additions to the specific indicators listed above include effluents discharged to water, marine spills, occupational health and safety statistics, etc.

2. As an alternative approach, the use of surrogate indicators (such as investment by industry in abatement ($/GJ) and compliance record vis a vis environmental and occupational health and safety legislation) was considered, but rejected as providing less detailed and reliable information than the recommended approach set out above.

3. Use of an "impact index" was also considered. This concept involves the calculation of an index for each particular energy source, and the tracking of changes in that index over time. (Ideally, the indices for different energy sources would be comparable, allowing aggregation; at least in the near-term, however, this seems unrealistic.)

The index might be developed as follows:

- For each energy source, a group of independent experts would be asked to identify the key environmental impacts; to assign relative weights to each (weight should reflect the importance of the *type* of impact, not the extent of the impact); and to identify measurable variables that would allow monitoring of the extent of each identified impact (on a national basis).

- At any given time, the index could be calculated for each energy source, based on the agreed upon weights (which would be fixed) and the measured extent of each impact (which would vary).

Such an impact index would, in principle, be an appropriate indicator of overall environmental impact, and could be readily converted to identify impact per unit of energy produced/used. In our view, however, development of such an index is probably impossible in the near term, due in part to the difficulty of arriving at agreed upon weights. (A similar but, we believe, less challenging problem is associated with Indicators 2.1 -2.4).

SELECTED METHODOLOGICAL ISSUES:

1. Adequacy of emissions, waste, and land use data and/or of our understanding of its significance

2. Relative weighting of different emissions, wastes, and land uses.

EXHIBIT 3

CHARACTERISTIC: LONG TERM RESOURCE AVAILABILITY[4]

DISCUSSION:

At any given time, long term resource availability is a function of a number of factors, including:

- Levels of energy consumption
- The mix of energy sources (renewable and non-renewable)
- The economically accessible reserves of each non-renewable resource, which in turn is dependent on physical reserves, current energy prices, and technology.

In other words, long term resource availability will increase as a result of 1) declining energy consumption; 2) changes in the energy mix towards renewables and/or towards those non-renewables with relatively large reserves; and 3) increases in economically accessible non-renewable reserves. Any indicator developed to measure long term availability should therefore address all of these factors.

One indicator that achieves this goal is: the portion of our energy consumption that is met by sources that are either renewable or have reserves adequate to meet current levels of Canadian

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[4] This characteristic encompasses one of the areas identified by the NRTEE for indicator development (sustainable supply -- energy mix/timely conversion to sustainable sources).

use for more than a given number of years (say 50 years). Because of its conceptual simplicity, this is the indicator we recommend below.

Calculation of reserves is perhaps the major methodological challenge associated with this indicator. Reliance on supply curves that plot reserves against price offers one option. Using these curves as a tool, the approximate life expectancy of each non-renewable energy resource can be calculated based on current annual Canadian usage and current energy prices (or other prices, as appropriate).

As noted above, this exhibit focuses on domestic energy use; the question of *additional* production for export is addressed in Exhibit 5. However, in calculating the available reserves at a given energy price, the it may be appropriate to reduce the reserves by the amount of any *committed* exports.

Finally, there are other dimensions to the question of resource availability, including national self-sufficiency, regional self-sufficiency, and security of supply. In fact, the indicator proposed here directly measures long term national self-sufficiency and could, through regional disaggregation, address the question of regional self-sufficiency (an important issue given the size of Canada and the great variation in energy resources across the country). The question of security of supply is not covered.

PROPOSED INDICATORS:

INDICATOR 3.1	**PROPORTION OF ENERGY USE MET BY ABUNDANT RESOURCES**
Indicator:	Proportion of energy use met by resources that are renewable or have reserves adequate to meet current levels of Canadian use for more than (say) 50 years (%)
Comment:	Reserves should be determined based on current energy prices. A second version of this indicator could incorporate reserves available at higher energy prices (say 125% of current)
Disaggregation:	Regional proportion (%) Sectoral proportion (%)

OTHER POSSIBLE INDICATORS:

1. An indicator of energy "richness" -- a measure of the diversity of energy sources making a significant contribution to Canada's energy balance

2. An indicator of security of supply, particularly on a regional basis. The indicator might address oil storage and delivery capacity, vulnerability of electrical transmission and generation, etc. Note, however, that security of supply is more related to short run dislocation than to long term sustainability.

SELECTED METHODOLOGICAL ISSUES:

1. Reliability of data concerning reserves

2. Definition of renewability (particularly given that existing data concerning renewable energy use does not distinguish sustainable from non-sustainable usage)

3. Selection of primary or secondary energy data.

EXHIBIT 4

CHARACTERISTIC: ENERGY PRODUCTIVITY OF THE ECONOMY

DISCUSSION:

A somewhat traditional indicator of the energy productivity of the economy is the size of the Gross Domestic Product (GDP) per GJ of energy consumption. This is not an ideal indicator because the GDP itself is imperfect -- but the wide acceptance and use of GDP suggests that it serve as at least an initial basis for the required energy productivity indicator.

It is worth noting that one of the important criticisms of the use of GDP in energy analysis is of limited significance in the present context. According to Schipper, for instance, "...use of the energy-GDP ratio can give very misleading signals about changes in energy efficiency."[7] The reason for Schipper's conclusion is that factors other than (technical) efficiency influence the ratio -- most importantly, structural changes in the economy. For our purposes, however, it is in fact desirable that the indicator reflect these structural changes.

PROPOSED INDICATORS:

INDICATOR 4.1	ENERGY PRODUCTIVITY
Indicator:	Real Gross Domestic Product per GJ of energy consumption ($/GJ)
Disaggregation:	Regional ratio ($/GJ)
	Sectoral ratio ($/GJ)

OTHER POSSIBLE INDICATORS:

1. Percentage of GDP spent on energy (production and use)

2. A national primary/tertiary energy ratio (tertiary energy refers to the amount of useful work actually done by the energy delivered to users).

3. For Indicator 4.1: Use of a different economic indicator, such as employment or an improved GDP-type indicator (when it becomes available).

SELECTED METHODOLOGICAL ISSUES:

1. Selection of appropriate GDP data

2. Treatment of the energy contribution to GDP.

EXHIBIT 5

CHARACTERISTIC: INDICATORS ASSOCIATED WITH ADDITIONAL PRODUCTION FOR EXPORT

DISCUSSION:

Because Canada imports and exports large quantities of energy, there are significant differences between levels of energy production and of domestic energy use. In Exhibits 1-

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[7] Schipper, Lee (1990). *Energy Saving in the U.S. and other Wealthy Countries: Can the Momentum be Maintained?* International Energy Studies, Lawrence Berkeley Laboratory.

4, indicators associated with the domestic market (including production and use) were proposed. This exhibit considers indicators associated with *additional* production for export.

In principle, such indicators should address the same characteristics as the indicators proposed for the domestic market (i.e. the quantity of energy; the environmental impact per unit of energy; long term resource availability; and the energy productivity of the economy). Each of these is addressed in turn below.

1. *Quantity of energy produced or used*

On a global basis, energy production levels are ultimately dependent on usage (although there is of course a feedback loop: supply influences price which influences demand). Moreover, from a global perspective the question of whether a given use is supplied from a foreign or domestic source is of secondary importance when considering *long term* sustainability.

Nevertheless, from the Canadian perspective, additional production for export is of consequence, and the impacts on sustainability from a national perspective are clearly related to the scale of the activity. Therefore, an indicator measuring additional energy production for export is required. Specifically, we propose an indicator that addresses *net exports* rather than gross, for two principal reasons. First, this "fits" with the indicators proposed in the previous exhibits, whereas a measure of gross exports would produce double counting within the family of indicators. Second, it is appropriate to regard off-setting imports and exports as convenient commercial arrangements rather than as factors to be considered in assessing sustainability.

Note that the indicator presented below refers to net energy exports. However, although Canada is a net exporter of energy at the aggregate level, this might not always be so. Moreover, at the level of individual commodities, considerable fluctuation in our import/export situation can be expected over time, and some regions of the country depend heavily on imported energy supplies. From this it follows that the net exports indicator could in some cases be a negative value.

2. Environmental impact per unit of energy

The same generic indicators outlined in Exhibit 2 (greenhouse gases, other air emissions, etc.) can and should be used to address the impacts of energy production for export. However, the actual data would require refinement to exclude the components of each impact associated with energy use (as distinct from production, transportation and other upstream impacts).

3. Long term resource availability

The same generic indicator outlined in Exhibit 3 (proportion of energy use met by abundant resources) can be adapted to reflect the impact of net exports (or net imports) on long term resource availability. Specifically, the indicator would compare Canadian reserves to the sum of annual domestic use and net exports (imports).

4. Energy productivity of the economy

The question of energy productivity of the economy is largely unrelated to the question of net exports. As such, we suggest that no further indicator is required to address this characteristic.

NOTE: There is substantial conceptual similarity between the indicators below and those presented earlier, but the two sets of indicators do speak to an entirely different set of policy issues. Accordingly, it may be worth developing the proposals below as part of the second generation of the family of indicators.

PROPOSED INDICATORS:

INDICATOR 5.1:	**NET ENERGY EXPORTS**
Indicator:	Net energy exports (GJ)
Disaggregation:	Net exports by energy source (GJ)
INDICATORS 5.2 - 5.5	**ENVIRONMENTAL IMPACTS**
Indicators:	Same as Indicators 2.1 - 2.4 in concept; however actual data would be different as it should exclude impacts of energy use.
Disaggregation:	None suggested
INDICATOR 5.6	**PROPORTION OF ENERGY PRODUCTION MET BY ABUNDANT RESOURCES**
Indicator:	Proportion of energy production (domestic use plus net exports) met by resources that are renewable or have reserves adequate to meet current levels of Canadian use for more than (say) 50 years (%)
Disaggregation:	None suggested

OTHER POSSIBLE INDICATORS:

1. For Indicator 5.1: Use physical quantities of the energy commodities rather that GJ
2. Variants on the "Other Possible Indicators" presented in Exhibits 1 - 3.

SELECTED METHODOLOGICAL ISSUES:

1. Use of primary or secondary energy data.

SECTION 5. CONCLUSION

The ideas and indicators outlined above represent a point of departure for further discussion, elaboration, refinement and eventually testing. Throughout this development process, and particularly at the testing stage, the central question must be: do the indicators serve the central purposes they were designed for? Above all, do they have the ultimate effect of influencing energy policy in the direction of sustainability?

The answer to this will depend on many factors, of course. Are the indicators sufficiently compelling to trigger action? Are they ambiguous or are their implications readily understood (particularly given that all of the indicators will not always move in the same direction)? Are the conclusions suggested by the indicators consistent with "real world" experience? Is the scope of the indicators sufficiently broad, or should additional questions (such as global energy reserves) be addressed?

In fact, we believe that useful, high impact energy indicators can be developed. Combined with an effective delivery system, such indicators could undoubtedly play an important support role in the move towards sustainability.

APPENDIX 4

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